CLAIMS

What is claimed is:

1. An iterative method of equalizing an input signal received over a digital communication channel, said method comprising:

(a) using a kernel density estimate where different values of a kernel size are indicative of either a blind or a decision-directed equalization mode;

(b) processing a received signal using a blind equalization mode;

(c) evaluating, on a block or sample basis, an error measure based on a distance among a distribution of an equalizer output and a constellation;

(d) updating the kernel size based upon the error measure thereby facilitating automatic switching between the blind and decision-directed equalization modes, where the kernel size is initially set to a value indicative of the blind equalization mode; and

(e) selectively applying blind equalization or decision-directed equalization to the input signal according to the updated kernel size for subsequent iterations of steps (c)-(e).

2. The method of claim 1, wherein the error measure is an estimate of a density distance.

3. The method of claim 2, wherein the density distance is calculated according to $\hat{f}_{Y^p}(z)=\frac{1}{L}\sum_{i=0}^{L-1}G_{\sigma_0}(z-Y_{k-i}^{p})$ or $\hat{f}_{S^p}(z)=\frac{1}{N_s}\sum_{i=0}^{N_s-1}G_{\sigma_0}(z-S_i^{p})$.

4. The method of claim 3, wherein the error measure is a recursive forgetting estimate of the mean-square error.

5. The method of claim 4, wherein the recursive forgetting estimate of the mean-square error is denoted as E_k and is evaluated according to

$E_{k+1} = \alpha E_k + (1-\alpha) \min_{i=1,\ldots,N_s} \left(Y_k^2 - S_i^2\right)^2$, where α is a forgetting factor, y_k is the equalized signal, and s_i is derived from a constellation.

6. The method of claim 1, said step (a) further comprising initializing a learning rate, the error measure, a forgetting factor, and at least one constant for updating the kernel size.

7. The method of claim 6, further comprising adjusting the learning rate.

8. The method of claim 1, wherein the kernel size is denoted as σ_k and is calculated according to $\sigma_k = f(E_k, \theta)$, wherein f is a function with predetermined constant parameter θ and E_k is the error measure.

9. The method of claim 8, wherein θ is comprised of predetermined constant parameters a and b.

10. The method of claim 1, wherein blind or decision-directed equalization is performed by multiplying the input signal with a vector of equalization coefficients.

11. The method of claim 10, said step (e) further comprising updating the vector of equalization coefficients.

12. The method of claim 11, wherein the vector of equalization coefficients is denoted as $\mathbf{w}_k$ and is updated according to $\mathbf{w}_{k+1} = \mathbf{w}_k \pm \mu_\sigma \nabla_{\mathbf{w}} J(\mathbf{w}_k)$, where $J(\mathbf{w}_k)$ is the matched power density function or the sampled power density function criterion, $\nabla_{\mathbf{w}}$ is the stochastic gradient, and μ_σ is the learning rate.

13. A system for performing an iterative method of equalizing an input signal received over a digital communication channel, said system comprising:

(a) means for using a kernel density estimate where different values of a kernel size are indicative of either a blind or a decision-directed equalization mode;

(b) means for processing a received signal using a blind equalization mode;

(c) means for evaluating, on a block or sample basis, an error measure based on a distance among a distribution of an equalizer output and a constellation;

(d) means for updating the kernel size based upon the error measure thereby facilitating automatic switching between the blind and decision-directed equalization modes, where the kernel size is initially set to a value indicative of the blind equalization mode; and

(e) means for selectively applying blind equalization or decision-directed equalization to the input signal according to the updated kernel size for subsequent operations of means (c)-(e).

14. The system of claim 13, wherein the error measure is an estimate of a density distance.

15. The system of claim 14, wherein the density distance is calculated according to $\hat{f}_{Y^p}(z) = \frac{1}{L}\sum_{i=0}^{L-1} G_{\sigma_0}(z - Y_{k-i}^p)$ or $\hat{f}_{S^p}(z) = \frac{1}{N_s}\sum_{i=0}^{N_s-1} G_{\sigma_0}(z - S_i^p)$.

16. The system of claim 15, wherein the error measure is a recursive forgetting estimate of the mean-square error.

17. The system of claim 16, wherein the recursive forgetting estimate of the mean-square error is denoted as E_k and is evaluated according to $E_{k+1} = \alpha E_k + (1-\alpha) \min\limits_{i=1,\ldots,N_s} \left(Y_k^2 - S_i^2\right)^2$, where α is a forgetting factor, y_k is the

equalized signal, and s_i is derived from a constellation.

18. The system of claim 13, said means (a) further comprising means for initializing a learning rate, the error statistic, a forgetting factor, and at least one constant for updating the kernel size.

19. The system of claim 18, further comprising means for adjusting the learning rate.

20. The system of claim 13, wherein the kernel size is denoted as σ_k and is calculated according to $\sigma_k = f(E_k, \theta)$, wherein f is a function with predetermined constant parameter θ and E_k is the error statistic.

21. The system of claim 20, wherein θ is comprised of predetermined constant parameters a and b.

22. The system of claim 13, wherein blind or decision-directed equalization is performed by multiplying the input signal with a vector of equalization coefficients.

23. The system of claim 22, said means (e) further comprising means for updating the vector of equalization coefficients.

24. The system of claim 23, wherein the vector of equalization coefficients is denoted as $\mathbf{w}_k$ and is updated according to $\mathbf{w}_{k+1} = \mathbf{w}_k \pm \mu_\sigma \nabla_{\mathbf{w}} J(\mathbf{w}_k)$, where $J(\mathbf{w}_k)$ is the matched power density function or the sampled power density function criterion, $\nabla_{\mathbf{w}}$ is the stochastic gradient, and μ_σ is the learning rate.

25. A machine-readable storage having stored thereon, a computer program having a plurality of code sections, said code sections executable by a machine for causing the

machine to perform an iterative method of equalizing an input signal received over a digital communication channel, said method comprising the steps of:

(a) using a kernel density estimate where different values of a kernel size are indicative of either a blind or a decision-directed equalization mode;

(b) processing a received signal using a blind equalization mode;

(c) evaluating, on a block or sample basis, an error measure based on a distance among a distribution of an equalizer output and a constellation;

(d) updating the kernel size based upon the error measure thereby facilitating automatic switching between the blind and decision-directed equalization modes, where the kernel size is initially set to a value indicative of the blind equalization mode; and

(e) selectively applying blind equalization or decision-directed equalization to the input signal according to the updated kernel size for subsequent iterations of steps (c)-(e).

26. The machine-readable storage of claim 25, wherein the error measure is an estimate of a density distance.

27. The machine-readable storage of claim 26, wherein the density distance is calculated according to $\hat{f}_{Y^P}(z) = \frac{1}{L}\sum_{i=0}^{L-1} G_{\sigma_0}(z - Y_{k-i}^P)$ or $\hat{f}_{S^P}(z) = \frac{1}{N_s}\sum_{i=0}^{N_s-1} G_{\sigma_0}(z - S_i^P)$.

28. The machine-readable storage of claim 27, wherein the error measure is a recursive forgetting estimate of the mean-square error.

29. The machine-readable storage of claim 28, wherein the recursive forgetting estimate of the mean-square error is denoted as E_k and is evaluated according to $E_{k+1} = \alpha E_k + (1-\alpha)\min_{i=1,\ldots,N_s}\left(Y_k^2 - S_i^2\right)^2$, where α is a forgetting factor, y_k is the

equalized signal, and s_i is derived from a constellation.

30. The machine-readable storage of claim 25, said step (a) further comprising initializing a learning rate, the error statistic, a forgetting factor, and at least one constant for updating the kernel size.

31. The machine-readable storage of claim 30, further comprising adjusting the learning rate.

32. The machine-readable storage of claim 25, wherein the kernel size is denoted as σ_k and is calculated according to $\sigma_k = f(E_k, \theta)$, wherein f is a function with predetermined constant parameter θ and E_k is the error measure.

33. The machine readable storage of claim 32, wherein θ is comprised of predetermined constant parameters a and b.

34. The machine-readable storage of claim 25, wherein blind or decision-directed equalization is performed by multiplying the input signal with a vector of equalization coefficients.

35. The machine-readable storage of claim 34, said step (e) further comprising updating the vector of equalization coefficients.

36. The machine-readable storage of claim 35, wherein the vector of equalization coefficients is denoted as $\mathbf{w}_k$ and is updated according to $\mathbf{w}_{k+1} = \mathbf{w}_k \pm \mu_\sigma \nabla_\mathbf{w} J(\mathbf{w}_k)$, where $J(\mathbf{w}_k)$ is the matched power density function or the sampled power density function criterion, $\nabla_\mathbf{w}$ is the stochastic gradient, and μ_σ is the learning rate.